

### Description

The  $\mu$ PD446 is a high-speed, low-power, 2048-word by 8-bit static CMOS RAM fabricated with advanced silicon-gate CMOS technology. A unique circuitry technique makes the  $\mu$ PD446 a very low operating power device which requires no clock or refreshing to operate. Minimum standby power current is drawn by this device when  $\overline{CS}$  equals  $V_{CC}$  independently of the other input levels. Data retention is guaranteed at a power supply voltage as low as 2V.

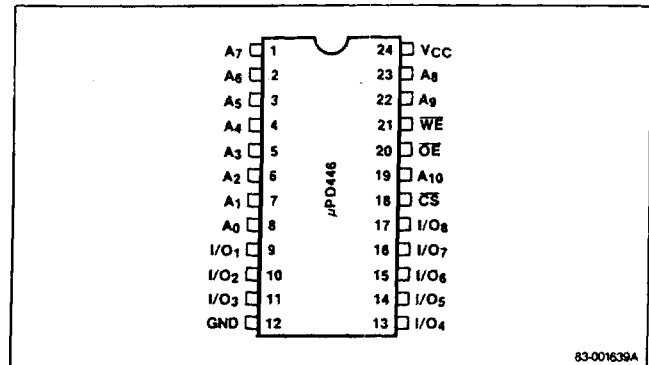
The  $\mu$ PD446 has a standard 24-pin dual-in-line package and is plug-in compatible with 16K EPROMs.

The  $\mu$ PD446 is also packaged in a miniflat package providing high density application.

### Features

- Single +5V supply
- Fully static operation — no clock or refreshing required
- TTL compatible — all inputs and outputs
- Common I/O using three-state output
- $\overline{OE}$  eliminates need for external bus buffers
- Max access/min cycle times down to 150 ns
- Low power dissipation
  - Active: 38 mA max
  - Standby: 10  $\mu$ A max
- Data retention voltage: 2V min
- Operating temperature range: -40°C to +85°C
- Standard 24-pin plastic package ( $\mu$ PD446C)
- Plug-in compatible with 16K EPROMs ( $\mu$ PD446C)
- Miniflat package for high density application ( $\mu$ PD446G)
- L version
  - Standby current 1.0  $\mu$ A max at 60°C for battery backup operation

### Pin Configuration



### Pin Identification

No.	Symbol	Function
1-8, 19, 22, 23	$A_0$ - $A_{10}$	Address input
9-11, 13-17	$I/O_1$ - $I/O_8$	Data input/output
18	$\overline{CS}$	Chip select
20	$\overline{OE}$	Output enable
21	$\overline{WE}$	Write enable
24	$V_{CC}$	Power (+5V)
12	GND	GND

### Performance Ranges

Device	Access Time (Max)	Cycle Time (Min)	Power Supply (Max)	
			Active	Standby
$\mu$ PD446C-3, 446G-15	150 ns	150 ns	38 mA	(Note 1)
$\mu$ PD446C-2, 446G-20	200 ns	200 ns	30 mA	(Note 1)
$\mu$ PD446C-1, 446G-25	250 ns	250 ns	26 mA	(Note 1)
$\mu$ PD446C, 446G-45	450 ns	450 ns	18 mA	(Note 1)

#### Note:

(1)  $\mu$ PD446C-L/-1L/-2L/-3L,  $\mu$ PD446G-45L/25L/20L/15L

$T_A = 25^\circ\text{C}$ , 0.2  $\mu$ A

$T_A = 60^\circ\text{C}$ , 1.0  $\mu$ A

$T_A = 85^\circ\text{C}$ , 10  $\mu$ A

$\mu$ PD446C/-1/-2/-3,  $\mu$ PD446G-45/25/20/15

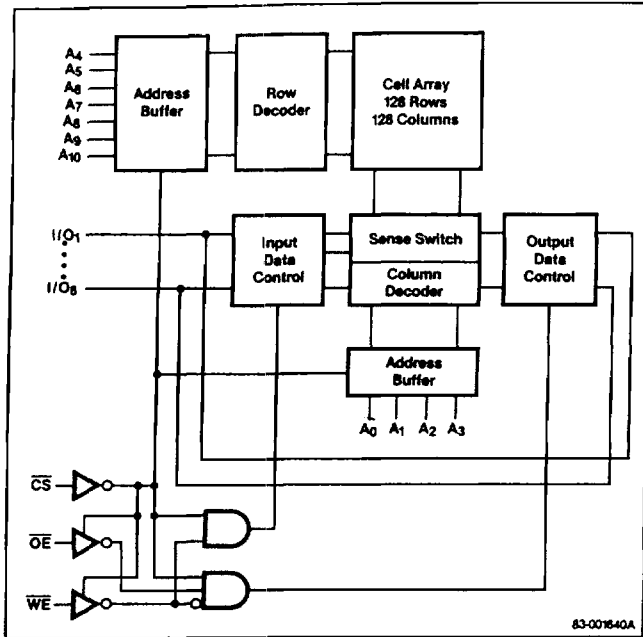
$T_A = 25^\circ\text{C}$ , 1.0  $\mu$ A

$T_A = 60^\circ\text{C}$ , 5.0  $\mu$ A

$T_A = 85^\circ\text{C}$ , 10  $\mu$ A

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**Block Diagram**



**Absolute Maximum Ratings**

Power supply voltage, $V_{CC}$	7.0 V
Input voltage, $V_{IN}$	-0.3 to $V_{CC} + 0.3$ V
Output voltage, $V_{OUT}$	-0.3 to $V_{CC} + 0.3$ V
Operating temperature, $T_{OPR}$	-40 to 85°C
Storage temperature, $T_{STG}$	-55 to 125°C

**Comment:** Exposing the device to stresses above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational sections of the specification. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Capacitance**

$T_A = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Input capacitance	$C_{IN}$		6		pF	$V_{IN} = 0\text{ V}$
Input/output capacitance	$C_{I/O}$		8		pF	$V_{I/O} = 0\text{ V}$

**Recommended DC Operating Conditions**

$T_A = -40$  to  $+85^\circ\text{C}$

Parameter	Symbol	Limits			Unit
		Min	Typ	Max	
Supply voltage	$V_{CC}$	4.5	5.0	5.5	V
Input voltage low	$V_{IL}$	-0.3		0.8	V
Input voltage high	$V_{IH}$	2.2		$V_{CC} + 0.3$	V

**DC Characteristics**

$T_A = -40$  to  $85^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Input leakage current	$I_{LI}$		1		$\mu\text{A}$	$V_{IN} = 0\text{ V to } V_{CC}$
I/O leakage current	$I_{LO}$		1		$\mu\text{A}$	$V_{I/O} = 0\text{ V to } V_{CC}$ $\overline{CS} = V_{IH}$ or $\overline{OE} = V_{IH}$ or $\overline{WE} = V_{IL}$
Operating supply current	$I_{CCA1}$		(1)	(1)	mA	$\overline{CS} = V_{IL}$ , $I_{I/O} = 0\text{ V min cycle}$
Operating supply current	$I_{CCA2}$		5	10	mA	$\overline{CS} = V_{IL}$ , $I_{I/O} = 0\text{ V DC current}$
Standby supply current	$I_{CCS}$	0.02	(2)		$\mu\text{A}$	$\overline{CS} = V_{CC} - 0.2\text{ V}$ , $V_{IN} = 0\text{ V to } V_{CC}$
Output voltage low	$V_{OL}$			0.4	V	$I_{OL} = 2.0\text{ mA}$
Output voltage high	$V_{OH}$	2.4			V	$I_{OH} = -1.0\text{ mA}$

**Notes:**

- (1)  $\mu\text{PD446C-3/3L}$ ,  $\mu\text{PD446G-15/15L}$ : 25 mA typ, 38 mA max  
 $\mu\text{PD446C-2/2L}$ ,  $\mu\text{PD446G-20/20L}$ : 20 mA typ, 30 mA max  
 $\mu\text{PD446C-1/1L}$ ,  $\mu\text{PD446G-25/25L}$ : 18 mA typ, 26 mA max  
 $\mu\text{PD446C/-L}$ ,  $\mu\text{PD446G-45/45L}$ : 12 mA typ, 18 mA max
- (2)  $\mu\text{PD446C-L/-1L/-2L/-3L}$ ,  $\mu\text{PD446G-45L/25L/20L/15L}$   
 $T_A = 25^\circ\text{C}$ ,  $0.2\ \mu\text{A}$   
 $T_A = 60^\circ\text{C}$ ,  $1.0\ \mu\text{A}$   
 $T_A = 85^\circ\text{C}$ ,  $10\ \mu\text{A}$   
 $\mu\text{PD446C/-1/-2/-3}$ ,  $\mu\text{PD446G-45/25/20/15}$   
 $T_A = 25^\circ\text{C}$ ,  $1.0\ \mu\text{A}$   
 $T_A = 60^\circ\text{C}$ ,  $5.0\ \mu\text{A}$   
 $T_A = 85^\circ\text{C}$ ,  $10\ \mu\text{A}$

## AC Characteristics

$T_A = -40$  to  $85^\circ\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$

Parameter	Symbol	μPD446C-3 μPD446G-15		μPD446C-2 μPD446G-20		μPD446C-1 μPD446G-25		μPD446C μPD446G-45		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
<b>Read Cycle</b>										
Read cycle time	$t_{RC}$	150		200		250		450		ns
Address access time	$t_{AA}$		150		200		250		450	ns
Chip select access time	$t_{ACS}$		150		200		250		450	ns
Output enable to output valid	$t_{OE}$		75		100		120		150	ns
Output hold from address change	$t_{OH}$	15		15		15		15		ns
Chip select to output in Lo-Z	$t_{CLZ}$	10		10		10		10		ns
Output enable to output in Lo-Z	$t_{OLZ}$	5		5		5		5		ns
Chip deselect to output in Hi-Z	$t_{CHZ}$		50		60		80		100	ns
Output disable to output in Hi-Z	$t_{OHZ}$		50		60		80		100	ns
<b>Write Cycle</b>										
Write cycle time	$t_{WC}$	150		200		250		450		ns
Chip select to end of write	$t_{CW}$	120		150		180		210		ns
Address valid to end of write	$t_{AW}$	120		150		180		210		ns
Address setup time	$t_{AS}$	0		0		0		0		ns
Write pulse width	$t_{WP}$	90		120		150		180		ns
Write recovery time	$t_{WR}$	0		0		0		0		ns
Data valid to end of write	$t_{DW}$	50		60		80		100		ns
Data hold time	$t_{DH}$	0		0		0		0		ns
Write enable to output in Hi-Z	$t_{WHZ}$		50		60		80		100	ns
Output active from end of write	$t_{OW}$	10		10		10		10		ns

## AC Test Conditions

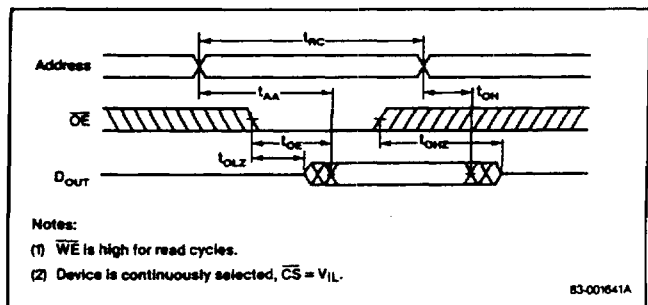
Input pulse levels	0.8 to 2.2 V
Input pulse rise and fall time	10 ns
Timing reference levels	1.5 V
Output load	1 TTL + 100 pF

## Truth Table

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	MODE	I/O	$I_{CC}$
H	X	X	Not selected	Hi-Z	Standby
L	H	H	Not selected	Hi-Z	Active
L	L	H	Read	$D_{OUT}$	Active
L	X	L	Write	$D_{IN}$	Active

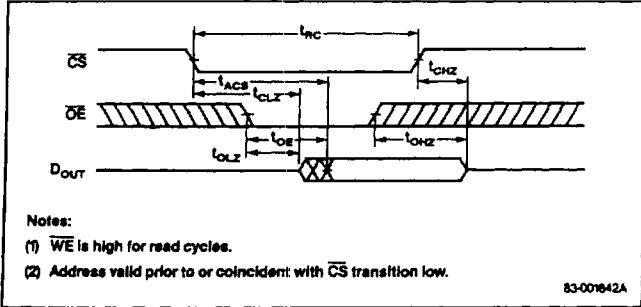
## Timing Waveforms

### Read Cycle No. 1

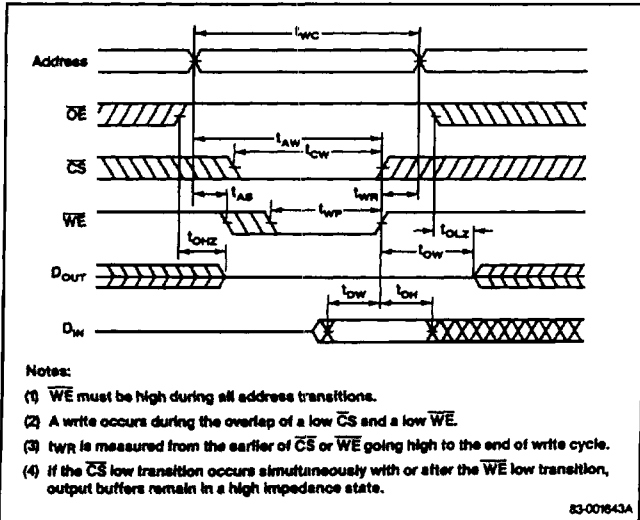


Timing Waveforms (cont)

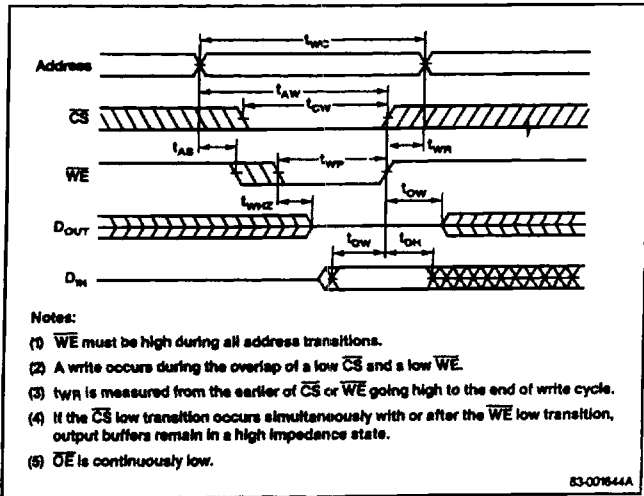
Read Cycle No. 2



Write Cycle No. 1



Write Cycle No. 2



Low V<sub>CC</sub> Data Retention Characteristics

T<sub>A</sub> = -40 to 85°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Data retention supply voltage	V <sub>CCDR</sub>	2.0			V	V <sub>IN</sub> = 0 V to V <sub>CC</sub> , CS = V <sub>CC</sub>
Data retention supply current	I <sub>CCDR</sub>		0.01	(1)	μA	V <sub>IN</sub> = 0 V to V <sub>CC</sub> , CS = V <sub>CC</sub> , V <sub>CC</sub> = 3.0 V
Chip deselection to data retention mode	t <sub>CDR</sub>	0			ns	
Operation recovery time	t <sub>R</sub>		t <sub>RC</sub>		ns	

Note:

- (1) μPD446C-L/-1L/-2L/-3L, μPD446G-45L/25L/20L/15L  
 T<sub>A</sub> = 25°C, 0.2 μA  
 T<sub>A</sub> = 60°C, 1.0 μA  
 T<sub>A</sub> = 85°C, 10 μA  
 μPD446C/-1/-2/-3, μPD446G-45/25/20/15  
 T<sub>A</sub> = 25°C, 1.0 μA  
 T<sub>A</sub> = 60°C, 5.0 μA  
 T<sub>A</sub> = 85°C, 10 μA

Low V<sub>CC</sub> Data Retention

